Programme on Energy, Environment, Resources, and Sustainability (PEERS)

Final Project Report

Electricity pricing strategies for demand side management

Submitted by:

M S Dave

Tata Electric Companies, Mumbai

February 1997

Tata Energy Research Institute, New Delhi

In collaboration with:
United Nations University, Tokyo

Center for Energy and Environmental Policy
University of Delaware, U S A

and with support from
European Commission (SYNERGY Programme)

Contents

1.0 Executive summary 1

2.0 Background 2

3.0 Introduction to demand side management 4

4.0 Scope & objective 5

5.0 Methodology 5

6.0 A case study on TEC 12

7.0 Recommendations 17

8.0 Conclusions 18

References 19

Annexures

Electricity pricing strategies for demand side management

1.0 Executive summary

One of the key economic indicators of a country is development of its energy infrastructure. While India presently faces serious energy deficits and shortages in peak capacity, there is a need for enormous investments in enhancing its energy infrastructure to sustain the accelerated economic growth that it is now poised for. To overcome the peak shortages, the consumers are increasingly resorting to captive generation essentially by diesel generator sets, which are inefficient and environmentally incompatible since they cause pollution at ground level. The approach so far has been to manage the situation by load shedding and plan additional capacities to meet increasing demand, both of which are not sustainable in the long run for obvious reasons.

It is necessary that the existing infrastructure be utilized optimally which in turn would not only reduce pressure on new development and on the environment but also result in better utilization of limited resources. There is also tremendous scope for energy conservation both on supply side and demand-side.

Demand Side Management (DSM), as the name suggests, deals with economic reduction in energy demand within the available capacity of a utility during its peak generating period. It offers a sustainable path to mitigate the above problems without jeopardizing the economic activities. A DSM program consciously attempts to alter the load profile with respect to time so as to effectively manage the load within the technical capability of utility's generating plants by peak shaving, valley filling, load shifting and strategic energy conservation. Two principal techniques employed for load profile alterations are tariff restructuring offering lower tariffs for off-peak loads and interruptible loads, higher tariff for peak power prompting the consumers to shift to off-peak periods and direct control of certain interruptible loads of consumers.

To alleviate its critical energy and peak capacity shortages and the nightmares being experienced by utility planners and managers in India, DSM offers a sustainable path. Besides its ability to address shortages in energy and peak capacities, DSM may also assist in a shift from the regime of load shedding to altering load shapes over the long term, avoided capacity addition by the utilities and reduction in energy costs to consumers and inherent environmental benefits from DSM programs.

There are three key barriers to DSM in India, viz., Financial Barriers (no incentive to either the utilities or to the consumers to adopt energy-efficiency measures), Institutional Barriers (lack of knowledge, experience and expertise) and Technical Barriers (higher costs and limited availability of DSM equipment)

This report studies DSM opportunities in Tata Electric Companies' system and comes to a conclusion that while a direct DSM programme may be feasible at a later stage when the load growth catches up with the installed capacity, what can be immediately done is to improve generation efficiency by inducing a demand for off-peak energy by marginal costing method from neighbouring State of Karnataka, who in turn could conserve its hydel resources for meeting peak demand.

2.0 Background

Energy infrastructure of a country has now come to be recognized as one of the indicators of its economic prosperity. Like most developing countries, India is now poised for accelerated economic growth which would need enormous investments in enhancing energy infrastructure. Presently, there are serious shortages in peak capacity and energy deficits. Table 1 gives region-wise installed capacities and the peak demands met during 1993-94 from which it would be clear that only 57.6% of the installed capacity was utilized to meet the peak demand on All India basis. However despite 42.4% of the installed capacity remaining unutilized there was a peaking shortage of 17%. Similarly, for the same period the energy shortage was 7.3% as would be seen from Table 2. The scenario during 1996-97 is not expected to worsen although there is likely to be a slight improvement in the capacity utilisation.

Table 1. Regional Installed Capacities & Peak Demands Met[1] in 1993-94

Region	Installed Capacity	Peak Demand Met (MW)	Peak Demand Met as a % of Installed Capacity
North	22,951	13,825	60.2
West*	22,963	15,052	65.5
South	18,256	10,087	55.3
East	11,273	4,520	40.5
North East	1,141	610	53.5
All India	*76,584*	*44,094*	*57.6*

* In 1995-96 the installed capacity of 24,036 met a peak demand of 20,836

Table 2. Region-wise Energy Requirement, Supply and Surplus/Deficit[2] (Gwh) in 1993-94

Region	Energy Requirement	Supply	% Surplus/ Deficit
North	97,370	90,530	- 7.0
West	99,576	95,680	- 3.9
South	84,735	77,461	- 8.6
East	37,910	32,530	-14.2
North East	3,661	3,287	-10 2
All India	*3,23,252*	*2,99,494*	*- 7.3*

The two major problems being faced by the electric utility managers and planners in India:

1. Shortages during peak periods and excess during off-peak periods which results in load shedding during peak periods and backing down of generation at off-peak hours with associated lower efficiencies.
2. Brown outs or low voltages due to highly inductive agricultural loads.

To overcome the energy shortages, the consumers are increasingly resorting to captive generation essentially by diesel generator sets, which are not only inefficient and eat into scarce petroleum resources, but are also environmentally incompatible since they cause pollution at ground level.

So far, the approach of the utility managers and planners has been two fold, viz.:

1. Load management, which essentially means restricting the demand by load shedding
2. Plan additional capacities to meet increasing demand.

The first solution is not desirable as it does not support economic development and the second approach, by itself, is not sustainable for a variety of reasons, viz., severe financial constraints, increasing environmental impact of power development projects, limited availability of traditional natural resources, etc.

In this context, it is necessary that the existing infrastructure be utilized optimally (by bringing in efficiency by modernization, renovations, repowering, retrofitting, beneficiation of fuel, etc and for which there is enormous scope in most developing countries), which in turn would not only reduce pressure on new development and on the environment but also result in better utilization of limited resources. There is also tremendous scope for energy conservation both on supply side, where auxiliary consumption is high at 10% as compared to the industry norm of 5-6%, and on *demand-side* as would be evident from Table 3.

Table 3. Energy Requirements in Typical Energy Intensive Industries[3]

(kg of oil equivalent/ tonne)

	India	*UK*	*USA*	*Japan*
Cement	950	607	606	418
Steel	200	130	95	120
Fertilizer	1,113	762	970	-

3.0 Introduction to demand side management (DSM)

DSM, as the name suggests, deals with economic reduction in energy demand within the available capacity of a utility during its peak generating period. It offers a sustainable path to mitigate the above problems without jeopardizing the economic activities. A successful DSM program would result in:

1. Reduced capital expenditure for supply expansion to meet increasing demand
2. Improved system reliability, viz., stability of frequency and voltage of supply
3. Reduced environmental impact from improved operating efficiencies of both the utilities and the consumers as also doing away with the need for captive power generation
4. Conservation of depleting fossil resources by effecting improvement in end-use efficiencies
5. Mitigation of rising tariff impact afforded by innovative tariff restructuring.

4.0 Scope & objective

The scope of this report is to review various DSM techniques with focus on Electricity Pricing as a DSM tool. The objective of the study is to:

1. Investigate applicability of Electricity Pricing as a tool for DSM in Tata Electric System
2. Explore other avenues for flattening the load profile.

5.0 Methodology

The methodology adopted would focus on:

- Review of DSM techniques and Electricity Pricing as a tool for DSM
- DSM opportunities in India and the barriers to the same
- A case study on Tata Electric Companies system which would involve defining the selection criteria for the target group, analysing typical daily load data of the targeted group and examining the possibility of implementation of DSM for the target group with a view to altering the load-profile as well as exploring other avenues for flattening the load profile.

5.1 *Review of DSM techniques*

The daily, weekly and seasonal electric power consumption patterns show considerable variability. The load profile may vary with respect to type and number of customers which may result in a series of peaks (maximum demand) and valleys (minimum demand). A DSM program consciously attempts to alter the load profile with respect to time so as to effectively manage the load within the technical capability of utility's generating plants by:

1. Peak shaving
2. Valley filling
3. Load shifting
4. Strategic energy conservation

Principal techniques employed for load profile alterations are:

1. Tariff restructuring offering lower tariffs for off-peak loads and interruptible loads, higher tariff for peak power prompting the consumers to shift to off peak periods
2. Direct control of certain interruptible loads of consumers
3. Load reduction by end-use efficiency improvement

Over the last 15 years or so, U.S. has given major thrust to DSM. As per an Energy Information Administration / U.S. Electric Utility Demand Side Management Report[4] actual peak-load reduction in 1993 was 23,069 MW of which energy efficiency program, interruptible load program and direct load control program accounted for 45%, 29% and 17% respectively. As per Survey of Innovative Rates[5], 1991, over 616 million MWh were sold to nearly 5 million customers using over 1,000 innovative rates by the U S. Utilities. This report would focus on electricity pricing as a tool for effecting DSM.

5.2 *Electricity pricing as a DSM tool*

Pricing policy is a valuable soft tool for managing demand and reducing electricity consumption. The effects of a correct pricing policies are enhanced by coordinating their use with the other soft techniques of demand management, such as educating the consumers for reduction in the peak demand by energy conservation and affording certain financial tools like tax incentives, soft loans, etc. for propelling its implementation as well as with the hard methods of demand management, including direct control of loads, curtailment, etc. The integrated use of soft and hard techniques of demand management is most important since the former are more effective in the long run, whereas the latter have greater effect in the short run.

Resource crunch and environmental issues are causing utilities to take a hard look at the costs of new plant construction. Pricing options that offer to change customer consumption patterns and allow utilities to use existing resources more efficiently are becoming increasingly attractive. They also meet the objectives of sustainability both from resources as well as from environment point of view since they result in better utilization of resources, reduction in overall energy consumptions and in developing countries like India also mitigation of pollution hazards caused by captive diesel generator sets that are pressed into service by the customers to overcome load shedding.

Market based pricing is not new to the electric power industry. In early 1900, Tata Electric Companies, offered incentives to textile consumers in Bombay to change over from the then traditional steam engine powered machines to electric motors run by clean hydel power. Similarly around the same time in the U.S., most electric utilities priced by end use as well as by kWh consumption[6]. As the electric applications grew and it became impractical to count the number of appliances in a home or differentiate between the end uses, utilities began to install simple energy and demand meters to measure consumption. However the changing operating environment due to volatile fuel costs, environmental regulations and fewer technological advancements did not offer opportunities to reduce the prices. The utilities responded by beginning to look beyond traditional rate designs for new ways of tailoring prices and offering services. The strategies could include[6]:

1. *Segmenting Markets* to different types of customers. Most electric utilities separate their customers into residential, commercial and industrial groups as well as by voltage and demand levels. In India there is another category, viz., agriculture. Tariffs could be strategically targeted to any or all of the groups. However, for it to become successful the feeders need to be segregated, which in case of India would require substantial investments in view of mixed nature of users.

2. *Defining Products* to enable the customers to select the product that fulfills their desired objectives, e.g., interruptible and curtailable tariffs. Customers who are willing to live with less reliable service could be given discounts from otherwise applicable rates.
3. *Creating Customer Incentives* to encourage the customers to behave in different ways which fulfill strategic objectives, e.g., rebate for utilizing electricity at off-peak periods, which they would have otherwise utilized during peak periods.
4. *Signaling Competitors* to behave in a manner that benefits all parties. However, being regulated, electric utilities normally do not deliberately signal competitors but since they are major suppliers of energy needs, their rates often act as benchmark prices for alternative forms of energy and for decisions about co-generation or self-generation.

Since the functioning of a electric utility is regulated, its tariffs are required to meet the regulatory guidelines and need the approval of the regulatory authorities. While the business and policy objectives of the utilities and the regulators often differ, one area - customer welfare- provides common ground. Customer welfare can be defined as the difference between what customers are willing to pay for electricity and prices that are actually charged to them. By enhancing customer welfare, both regulators and utilities can:

- Reduce the overall cost of service
- Reduce rates by customer segment
- Provide higher value service to individual customers
- Provide a higher average level of service to all customers
- Increase sales where customer value exceeds incremental costs and decrease sales where the cost of service is greater than the value received[3].

Market-based pricing mechanism could be used to increase customer welfare in three ways, viz.:

1. Tariff reduction to enable load shifts from peak to off-peak periods. The customers gain since their energy bills go down and the utilities also gain by avoiding the need

to put up new capacities to meet the demand or by reducing their high cost peak power purchases from other utilities. Detroit Edison has recently adopted an interruptible rate that is expected to reduce industrial (peak) demand by 650 MW. San Diego Gas & Electric offers a special time of use tariff (lower than its standard time of use rate) to customers that install conservation related equipment[6]. Pennsylvania Power & Light Company offers upto two demand free days weekly - demand registered on such days will not be used for billing purposes with a proviso that incremental cost to utility must be less than the energy charge under schedule and sufficient capacity must be available to meet the load[5].

2. Load growth and load retention by offering lower rates to some customer. This concept is sometimes resisted as it appears that other customers are being asked to cover a greater share of fixed costs. But if the load is truly in the danger of being lost, special rates result in lower rather than higher prices to other customers since without the pricing initiative, all the fixed costs previously assigned to a lost load would have been reallocated to remaining customers.
3. Better Products, More Options - Product quality and service are also important aspects of power purchase decisions. Popular service options include power quality programs, design assistance, end-use equipment sales/ leasing, maintenance, etc.

The value of DSM applications can be estimated as the costs of generation and transmission & distribution (T&D) avoided by utilities with the operation of such programs. Traditionally, this value has been based on system-wide costs with the focus primarily on generation and assumes that costs are avoided equally regardless of location. The emergence of competition on a wider scale than it exists today may result in break-up of electric utilities into separate generation companies and T&D utilities. Hence, continuation of end-use efficiency goals in utility resource planning would require a redesign of DSM programs so that benefits accrue to both generation and T&D parts of utility operation. Targeted DSM applications, specific to area of the grid and time of use, would need to be evolved to create the flexibility and opportunity for cost savings for the utilities[7].

5.3 DSM opportunities in India

To alleviate its critical energy and peak capacity shortages and the nightmares being experienced by utility planners and managers in India, as seen earlier in this report, DSM offers a sustainable path. Besides its ability to address shortages in energy and peak capacities, DSM may also assist in the following:

- A shift from the regime of load shedding and brown outs to controlling and altering load growth and load shapes over the long term.
- Avoided capacity addition by the utilities and reduction in energy costs to consumers both due to efficiency improvements and avoidance of need to rely on otherwise expensive and inefficient captive power generation.
- Inherent environmental benefits from DSM programs.

The concept of time of the use (TOU) tariff has been introduced the four State Electricity Boards of Gujarat, Maharashtra, Tamil Nadu and West Bengal. However. as per a recent study by TERI for GEB, who have the longest experience with TOU tariff of over a decade, only 15-20% HT consumers were availing of the benefits of concessions offered by TOU tariff for off-peak period. This obviously did not result in meeting the desired objective of shifting the load profile, although it did result in additional revenue for GEB by way of penal rates for use of power during peak periods.

5.4 Barriers to DSM in India

Before we examine the barriers to DSM in India, it would be useful to understand the current electricity pricing policies and legislation. In India, generation, transmission & distribution of electricity is regulated by The Indian Electricity Act, 1910 and The Electricity (Supply) Act, 1948. Bulk of the electricity is generated by the State owned Electricity Boards (SEBs) and by the Central Government owned Generating Company, viz., National Thermal Power Corporation. Besides these two major players, there are a few private sector Licensees such as the Tata Electric Companies (TEC), BSES Ltd, CESC Ltd, Ahmedabad Electric Supply Co. Ltd., etc., generating and distributing electricity in their respective licensed area. The tariffs charged by the Licensees, SEBs and the Generating Companies are governed by the Electricity (Supply) Act, 1948 and are regulated by the State Government in case of the Licensees and the State Electricity Boards and by the Central Electricity Authority for Generating Companies like the National Thermal Power Corporation, National Hydro-Electric Power Corporation, etc. Recent liberalization initiatives have thrown open the power sector to the private sector as Independent Power Producers and their tariffs are based on competitive bidding and are negotiated by the SEBs.

As per the provision of the Electricity (Supply) Act, the tariff cover the all costs associated with generation, transmission and distribution of electricity, while allowing a reasonable return on the capital investments employed for these purposes. The industrial and commercial tariffs are charged on two parts basis consisting of a maximum demand charge (per kVA) and an energy charge (per kWh). In addition to the basic rates, there is also a Fuel Adjustment Charge which varies with the cost of fuel consumed. The tariffs for the residential consumers are generally subsidized. They are not levied any demand charge and the energy charges are normally levied in slabs or blocks i.e. lower charge for the first slab and so on. Similarly the fuel adjustment charge is generally not charged for the lower slabs. The agriculture sector is cross subsidized. Till recently, many SEBs were supplying electricity to the agriculture sector free of charge while others were charging either a nominal flat rate per connection or fixed charge linked to the capacity of the water pumps and as a result most SEB were unable to recover their costs. However, the State Governments are now seriously considering levying a minimum charge from this sector and some of SEBs have already specified a minimum tariff per kWh. On the other hand, there is no provision under the Act to charge for reactive power, which is largely responsible for low voltages and higher T&D losses.

There are three key barriers to DSM in India:

Financial Barriers

- The current legislation and policies on electricity pricing in India do not give any incentives to either the utilities or to the consumers to adopt energy-efficiency measures. In fact, the cross-subsidization of rates to certain sections of society, actually result in wasteful usage which at times also adversely affect the power quality, viz., the voltages and the frequency. As for as utilities are concerned, most of the revenue is accounted for by large consumers, viz., industrial and commercial consumers, and any reduction in energy consumed by them would unfavorably affect the utilities.

- Energy efficient products are generally more expensive and not affordable by a large section of the society and the consumers are normally more sensitive to the first time costs rather long term gains.
- Limited financial mechanism and experience in financing energy-efficiency product.
- The current regulatory mechanisms do not allow utilities from making DSM investments.
- The benefits offered by the present TOU tariff schemes are not considered adequate to compensate the extra effort required and associated inconveniences with off-peak utilization.

Institutional Barriers

- Lack of knowledge for DSM planning and evaluation in several key Government institutions.
- Lack of experience in SEBs for planning, implementation and monitoring of DSM programs.
- Lack of expertise to perform and deliver the services.
- Lack of partnership between utility and consumers.
- Lack of public awareness.
- Apprehension amongst consumers that night hour working would affect production, qualitatively and quantitatively.
- Female workers are to be excluded from night working.
- Reluctance on part of workers to work at night.

Technical Barriers

- Generally higher capital costs and limited availability of DSM equipments in developing countries.

- Inferior quality of equipments such as pumps, motors, etc., manufactured by small scale industries, but widely accepted due to low initial costs.
- Technological obsolescence
- Lack of segregation of loads due to mixed feeders, which hinders targeting DSM to a particular section.

6.0 A case study on TEC

Against the above backdrop, it may be interesting to study the DSM opportunities in a utility in India. viz., Tata Electric Companies (TEC).

Incorporated in 1910, TEC is the largest and the oldest of a handful of private utilities in India. Through its three hydel power stations (totaling 294 MW) located in the foothills of the Western Ghats near Bombay and a 1330 MW thermal power station at Bombay, it meets the requirements of electricity in its licensed area in Greater Bombay. It operates in an interconnected system with Maharashtra State Electricity Board (MSEB) and supplies power to two bulk licensees, viz., BSES & BEST, large industrial/ commercial consumers and to the railways. Over the years, the load in TEC system has grown multifold but their addition to the generating capacity had not been able to keep pace, primarily due to regulatory authorities denying permission for expansion. To meet its obligations and mitigate the deficit, TEC has entered into a power purchase agreement with MSEB, whereby TEC pays a fixed maximum demand charge per month plus the energy charges for actual purchases. A comparison of tariff structures of TEC and MSEB is given in Table 4, from which it would be seen that MSEB's energy tariff is higher by over 40%.

Table 4. Comparative tariffs of MSEB and TEC as on February 1997

	MSEB	TEC	Industries	BSES/ BEST
MSEB	-	Rs 450/ kVA for 550 MVA + Rs 2.88/ kWh	Rs 170/ kVA + Rs 3.07/ kWh	-
TEC	Rs 2.88/ kWh (no formal agreement)		Rs 170/ kVA + Rs 1.97/ kWh	Rs 170/ kVA + Rs 1.29/ kWh (Ist 25%) Rs 1.93/ kWh (balance 75%)

However, despite the arrangement with MSEB, they had not been able to supply the peaking power to TEC, in the past, due to shortages in their own system and being operating in an interconnected system, TEC had to resort to automatic load shedding to their consumers by operation of under-frequency relays. On the other hand, the system experiences higher frequencies due to lower loads during off-peak periods, especially during night resulting in backing down of its generation and associated lower efficiencies as would be seen from Graph 1 (see annexures) depicting a typical hourly load curve. Another problem being faced is that of low voltages, especially during periods when the agricultural load in the system goes up as would be seen from Graph 2 (see annexures).

So far TEC have endeavored to overcome the above problems by bringing in constant improvements in the supply side management. Since 1980s, TEC have installed 1,000 MW of additional thermal capacity while ushering in technological advances both in generation and distribution. They constantly improved the efficiency of generation and reduced transmission & distribution losses through higher voltages as also through voltage improvements by capacitor banks and synchronous condensers. They are the first utility in India to have gone in for installation of a 150 MW pumped storage plant to improve their peaking capability while utilizing the excess thermal capacity during off-peak periods. This plant installed at one of their hydel stations utilizes the existing infrastructure including the head and tail pond. TEC have also been on the forefront of environmental improvement by adopting state of the art technologies, changing over to cleaner fuels as also by installation of pollution abatement equipments, such as high efficiency electro-static precipitators, flue gas desulphurization equipment and fly-ash aggregate plant. Today, TEC operates power plants under emission limits which are more stringent than most U.S. and European standards.

The emphasis in TEC has been on the supply side improvements and DSM has not received as much attention, probably due to barriers indicated above, although TEC have installed capacitor banks at most of their receiving stations as well as synchronous condensers at their generating station and have been offering some advise to the consumers in the area of sub-station design, equipment selection, improvement of power factor, etc. However, it has been realized that investment in DSM could bring in the fruits which would be far more sustainable. In the absence of any incentives for investing in energy-efficiency programs, the key area which has been identified as innovative pricing with the objective of

1. Shifting some of the peak loads to off-peak period thereby reducing TEC's off-take of much expensive MSEB power. The saving from reduced purchase costs could be used to subsidize the off-peak tariff.
2. Develop additional load for off-peak period to facilitate optimal utilisation of thermal capacity with inherent benefit of sustainability.

However, while designing this tariff, sufficient disincentives may have to be built in to discourage the consumers from using power during peak period.

For design and implementation of innovative tariffs, modern micro-processor based meters, capable of registering consumptions at different times of day, are a must. TEC have already initiated action towards this end and have installed over 40 such meters and the data is being presently collected for further analysis.

6.1 Data analysis

TEC have fifteen Receiving Stations from where they supply power to the two bulk licensees, viz., BEST & BSES, 120 large industrial/ commercial consumers and to the Railways. TEC distributed a total of 11,974 GWH of energy during 1995-96, which has been growing at a rate less than 2% per annum as against a growth rate of 10-11% per annum in the MSEB system. The energy balance for TEC is given in Graph 3 (see annexures. The category-wise distribution of TEC's sales is given in Graph 4 (see annexures), from which it would be seen that the two licensees account for about 65% of TEC's total supplies. The licensees in turn supply electricity to residential, commercial and small commercial consumers. Here it may be mentioned that to derive maximum benefit a DSM programme must be targeted to a specific group of consumers. In this respect, since both the licensees' supplies are on mixed feeders (domestic, commercial, industrial), they could not be included for a DSM programme until they segregate their loads by consumer types. Similarly, a DSM programme for the Railways can not be implemented since lower tariffs are not expected to induce suburban commuters to change their travel plans. It was therefore decided to investigate possibilities for DSM programme for TEC's direct consumers. For this purpose, after studying the hourly load curves for TEC's direct consumers of all the Receiving Stations, five Receiving Stations, viz.. Dharavi, Parel, Mahalaxmi, Vikhroli and Borivli, were identified to be having potential for DSM. The other Receiving Stations had either a fairly constant load profile (due to continuous process industry) or were predominantly catering to BEST/ BSES or had declining loads.

Hourly data of the direct consumers' loads for these Receiving Stations for typical days in representative seasons were collected and the load profiles are given in Graphs 5 to 11 (see annexures). These include load profiles on a holiday when the demand is expectedly low. The analysis would indicate that the profile of Mahalaxmi, Dharavi and Parel Receiving Stations, all predominantly feeding textile industries, is fairly stable with slight variations, except night load in case of Parel and Dharavi which is lower by 10-15%. However, the night loads in case of Vikhroli and Borivli are lower by 40-70%. It may however be noted that night loads are lower at Vikhroli and Borivli since the industries are either not running the third shift or are running skeleton services at night. In contrast, the TEC system load including the supplies to the licensees, experiences two distinct peaks, one in the morning from 9-11 AM and the other in the evening from 5-8 PM. The night loads are generally 50-60% of the peak demand.

Before we examine the potential for a possible DSM programme, it would be necessary to examine the maximum demand and energy requirement trends for various category of consumers. These trends are given in Graph 12 & 13 (see annexures). It would be noted from these trends that the requirement of the direct industrial consumers is declining. At the same time another important development has taken place 1996-97, viz., BSES, whose demand on TEC was 871 MW during 1995-96, have transferred over 300 MW of their loads to their own Dahanu Generating Station which in turn has reduced TEC's purchases from MSEB so much so that TEC are now net exporter of power to MSEB, even during the peak period. With the commissioning of 150 MW Pumped Storage Unit in pumping mode by end February 1997, the peaking capability of TEC would go up further.

From the above, it would appear that, for the present, giving lower tariff to the industries for shifting some of their load from the peak hours to off-peak hours would be counter-productive to TEC. As such a DSM programme by way of TOU tariff for altering the load profile is not implementable for the present but there would certainly be potential for DSM in future when the load growth catches up with the installed capacity.

Once the demand catches up with the capacity, Energy Saving Companies (ESCOS) may also offer a viable solution for curtailing peak demand requirement.

For the present what is required is to develop additional load during both the peak and off-peak periods. The feasibility exists for wheeling the surplus power to the neighbouring power starved States of Karnataka, Gujarat and Andhra Pradesh, using MSEB's network. While the peak power could be given to MSEB as is being done presently on need basis, wheeling it to Gujarat may offer a more sustainable solution in the short/ medium term. As for the off-peak surplus power, Karnataka offers an ideal solution, even though from a different region and therefore subject to regional fluctuations of voltage and frequency, due to its heavy reliance on hydel capacity even for off-peak energy requirement. To overcome the problem of regional fluctuations of voltage and frequency, a radial feed to Karnataka with a dedicated load, such as the border city of Belgaum, could be made using MSEB/ KEB network. It may also be feasible to meet the entire requirement of Belgaum, whether peak, normal or off-peak, from TEC, thereby releasing that much capacity to Karnataka for gainful utilisation elsewhere in the State. It may also be feasible to assist the northern grid using HVDC links between Vindhyachal and Singrauli.

While the technical feasibility exists for the above inter-regional and intra-regional supply of power, the implementability would necessarily be dependent on financial resolution of payment of bills, etc. As regards the electricity pricing, the same could be evolved on the basis of marginal costing, both for peak and off-peak power. However, in the case of off-peak power, it would necessarily have to be based on marginal cost of operation plus wheeling charges and T&D losses plus a reasonable profit.

7.0 Recommendations

Based on the above study, following recommendations are made:

1. Seriously pursue the possibility of developing off-peak load from neighboring State of Karnataka. In fact, a load centre like Belgaum may be provided a radial feed for its entire power requirement.

2. Monitor the load growth and load profiles of industrial consumers for future electricity pricing strategies which could be evolved around the following concepts:
    a) Time of the day tariff offering lower tariffs for off-peak loads and higher tariffs for peak power prompting the consumers to shift to off-peak periods
    b) Lower tariffs for interruptible loads which could be controlled directly by the utility managers
3. Devise a tariff for reactive power consumption by the consumers. This would however need to wait till the legislation is enacted to permit this.
4. Lower tariff to targeted sectors on light load days such as Sundays or National holidays. Incentive such as relief in maximum demand charges or demand free day, etc., could be built into the tariff.
5. TEC could also invest on development of energy conservation programs or develop Energy Saving Companies (ESCOS) since the legislation is, sooner or later, expected to be modified to permit recovery of investments by utilities in this field.

8.0 Conclusions

A good scope exists for DSM in India. For using electricity pricing as a DSM tool, lit is necessary to do load segregation by type of use, followed by installation of time of use meters for the target group.

A DSM programme based on electricity pricing for TEC is not implementable for the present but there would certainly be potential for DSM in future when the load growth catches up with the installed capacity. On the other hand a case exists for providing some incentive to the consumers for improvement of power factor and at the same time a tariff needs to be worked for the reactive power consumed by the industries, since this is expected to help in improvement of voltages and reduction in losses A tariff for this purpose could be devised after sufficient data is available from all the industries on their dynamic reactive power demand and adequate legislation is enacted permitting such a tariff. It would be worth monitoring and analysing the load profile of individual consumers for identification of future implementation of DSM programme.

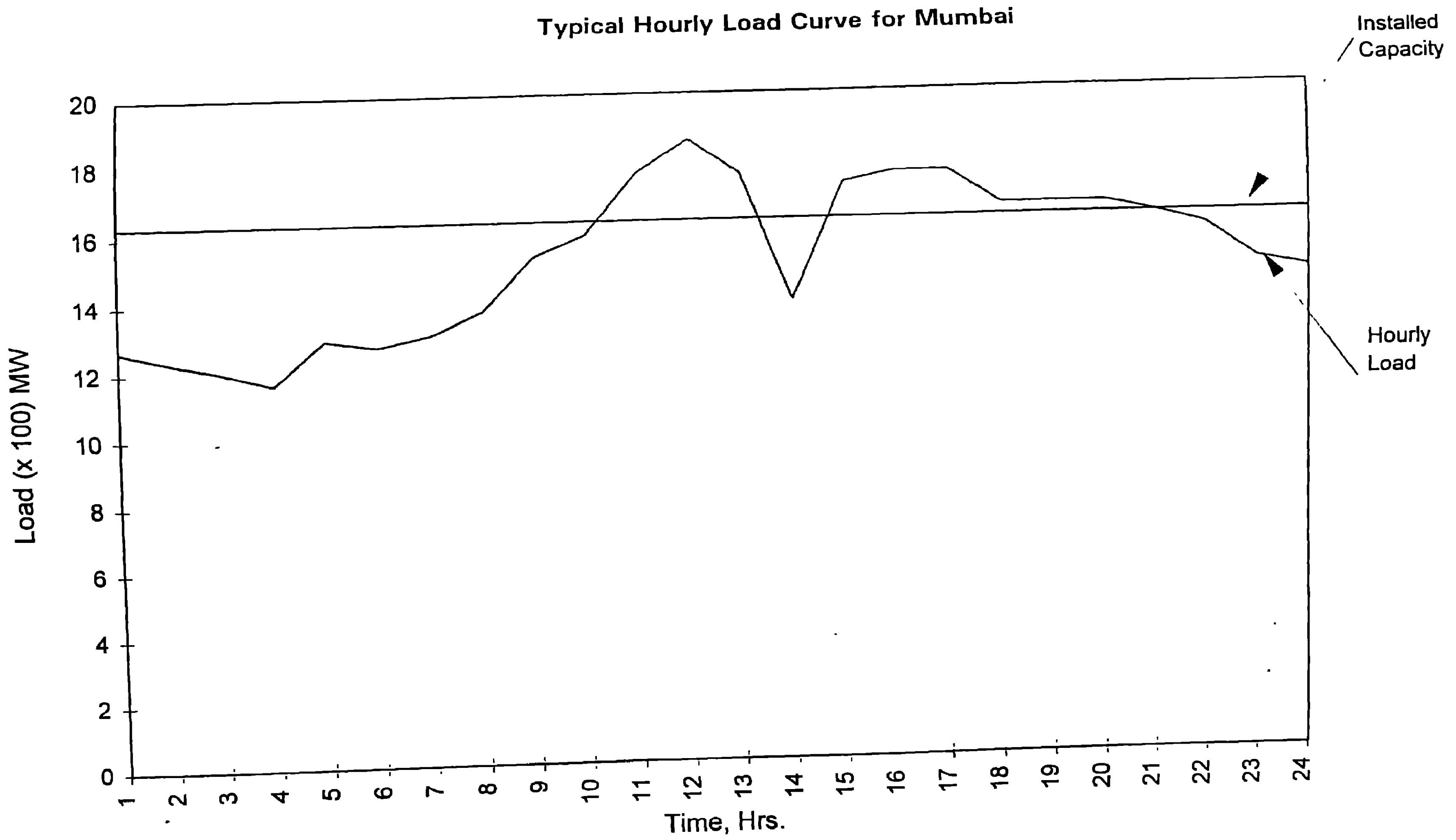
To improve the load demand at off-peak periods and thereby the efficiency of generation, a lower tariff with incentive such as relief in maximum demand charges or demand free day, etc., could be built into the tariff on the lines similar to Pennsylvania Power & Light Company[5] to targeted sectors on light load days such as Sundays or National holidays.

For the present, however, the surplus peak power of TEC, may be pumped to MSEB system whenever required, and as a more sustainable solution in the short/ medium term to GEB/ KEB (radial feed), which despite adequate installed capacity continue to face deficit at peak periods. While Maharashtra System has surplus capacity at off-peak hours, the neighboring state of Karnataka, which not only faces power deficit but also continues to be utlising its hydel capacity at off-peak hours to meet its demand. It would therefore be worth pursuing the possibility of supplying surplus off-peak thermal energy on marginal cost basis (marginal cost of generation, T&D losses, wheeling charges plus a reasonable profit) to Karnataka. This would require a dedicated radial feed and load in Karnataka, using MSEB's network to insulate the Maharashtra system from frequency and voltage fluctuations of the Southern Grid. The possibility may also be explored to feed the power to the Northern Grid using HVDC links of Power Grid Corporation. These should provide sustainable solution to conserve renewable resources and to overcome power famine in one region by optimally utilising the available surplus capacity in Tata Electric System.

References:

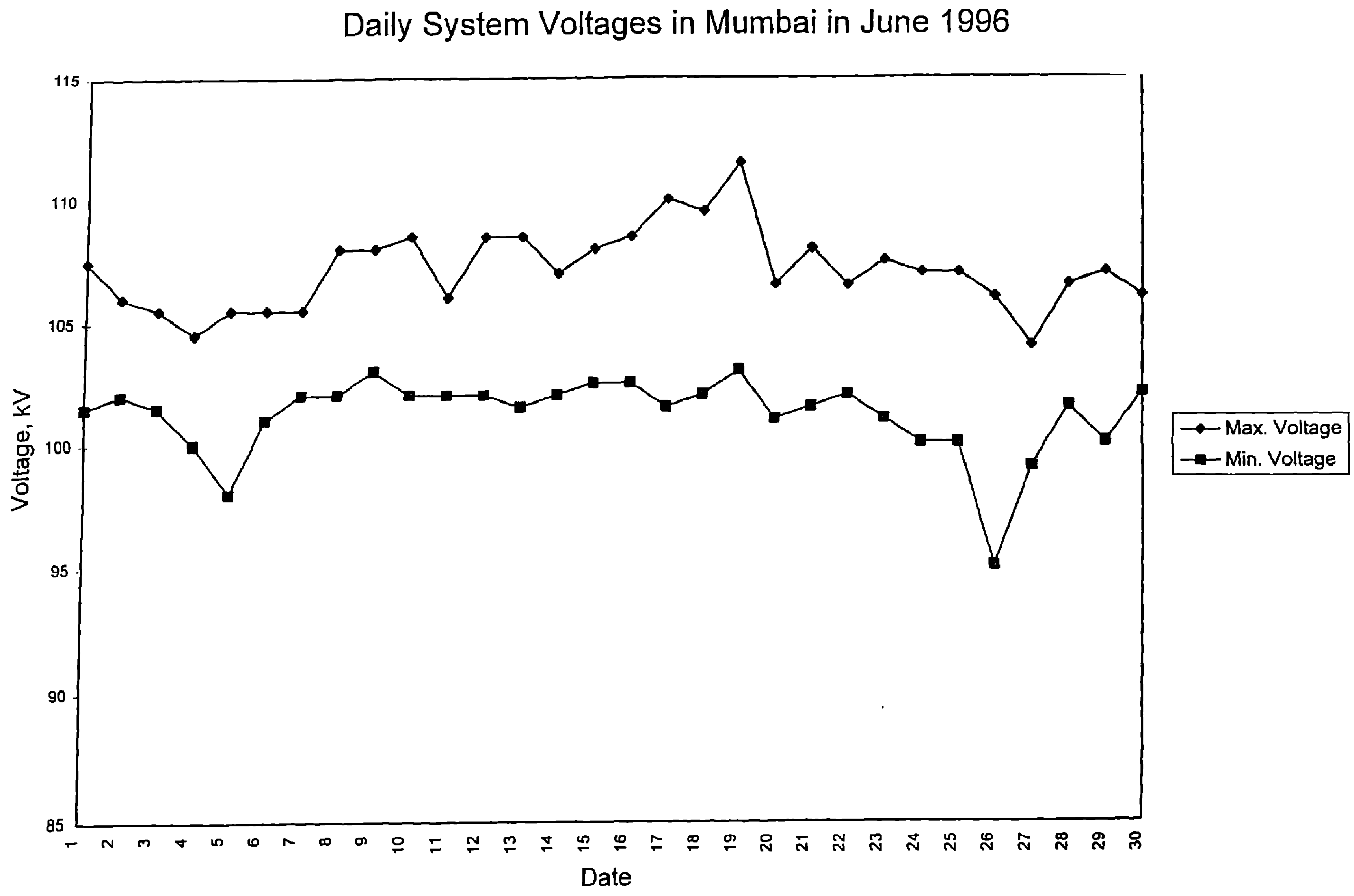
1. Monthly Progress Reports during 1994-95 of Various Regional Electricity Boards, Central Electricity Authority, Ministry of Power, Government of India
2. TERI Energy Data Directory and Yearbook (TEDDY) 1995/96
3. The Economic Times, Bombay, March 13, 1994
4. Electric Utility Demand-side Management, Energy Information Administration - July 1995, DOE/EIA-0589 (93)
5. Survey of Innovative Rates, 1991, Electric Power Research Institute, Vol. 3, April 1992, EPRI TR-100469
6. Thinking Strategically About Electricity Pricing, Electric Power Research Institute, December 1992, EPRI TR-101575
7. John Byrne, Young-Doo Wang and Craig McDonnell. Targeted Demand-side Management in a Competitive Utility Market, Center for Energy and Environment Policy, University of Delaware and Public Service Commission of Maryland (unpublished document)

Annexures



Graph 1

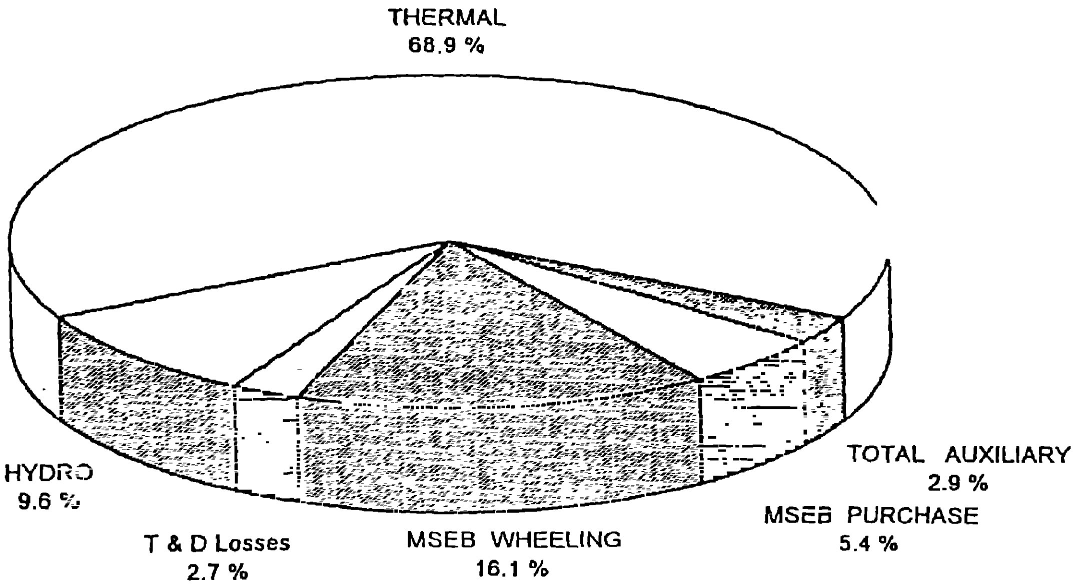
Tata Electric Companies, Muimbai



Graph 2

Tata Electric Companies, Mumbai

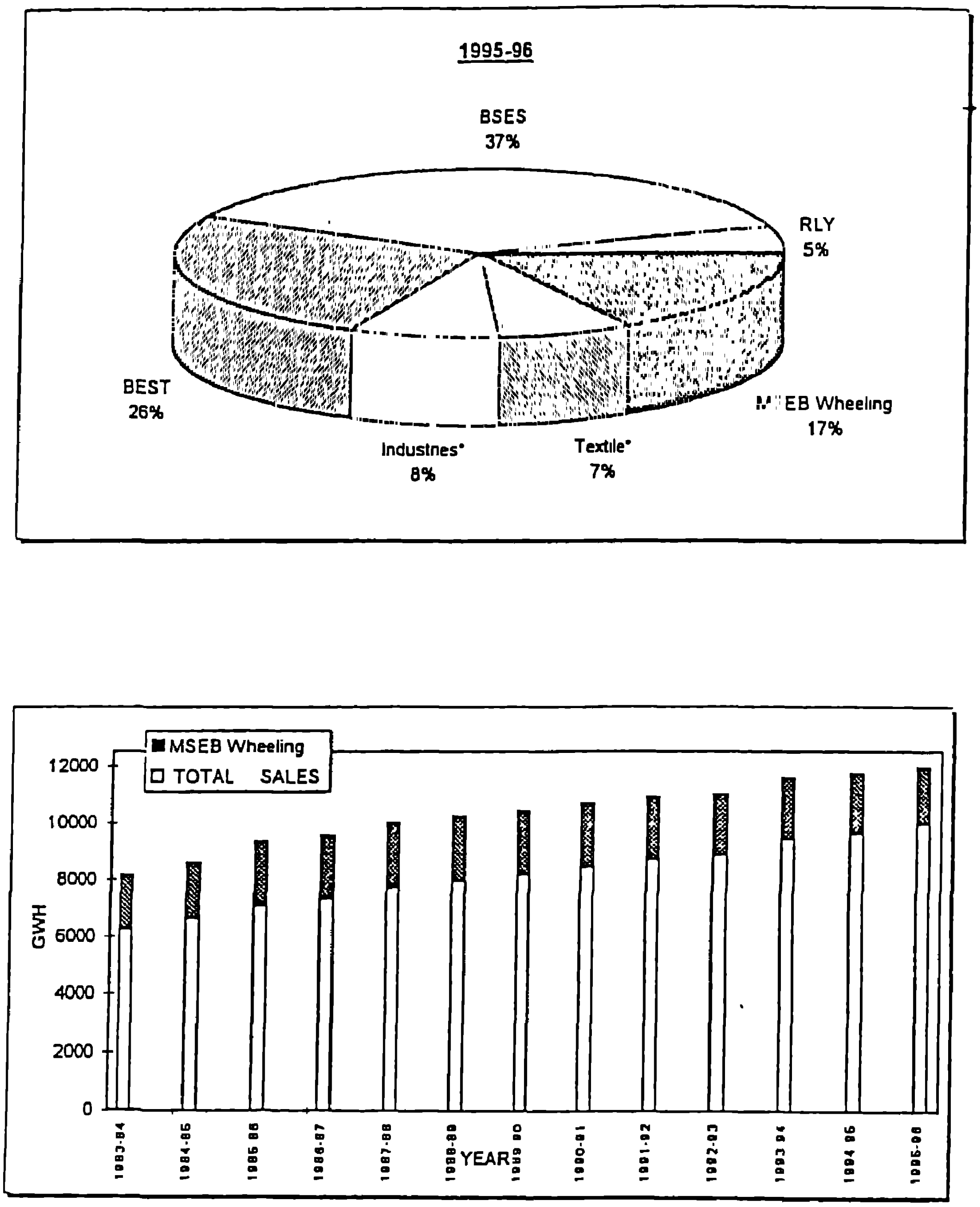
1995-96



Graph 3

Tata Electric Companies, Mumbai

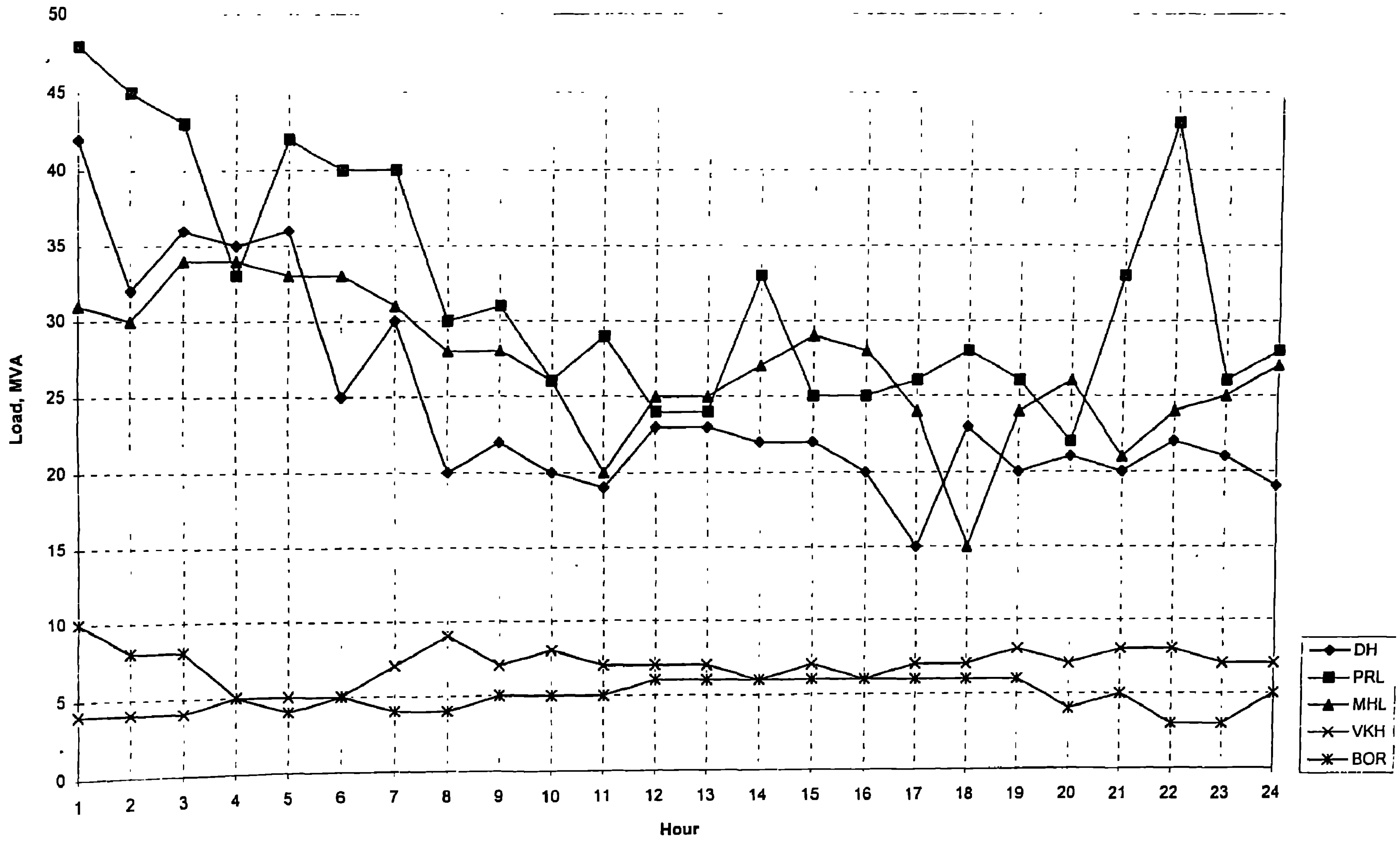
ENERGY SALES TO DIFFERENT CATEGORIES OF CONSUMERS



Graph 4

Tata Electric Companies, Mumbai

Hourly Load Curve for 14/4/96 (Holiday)

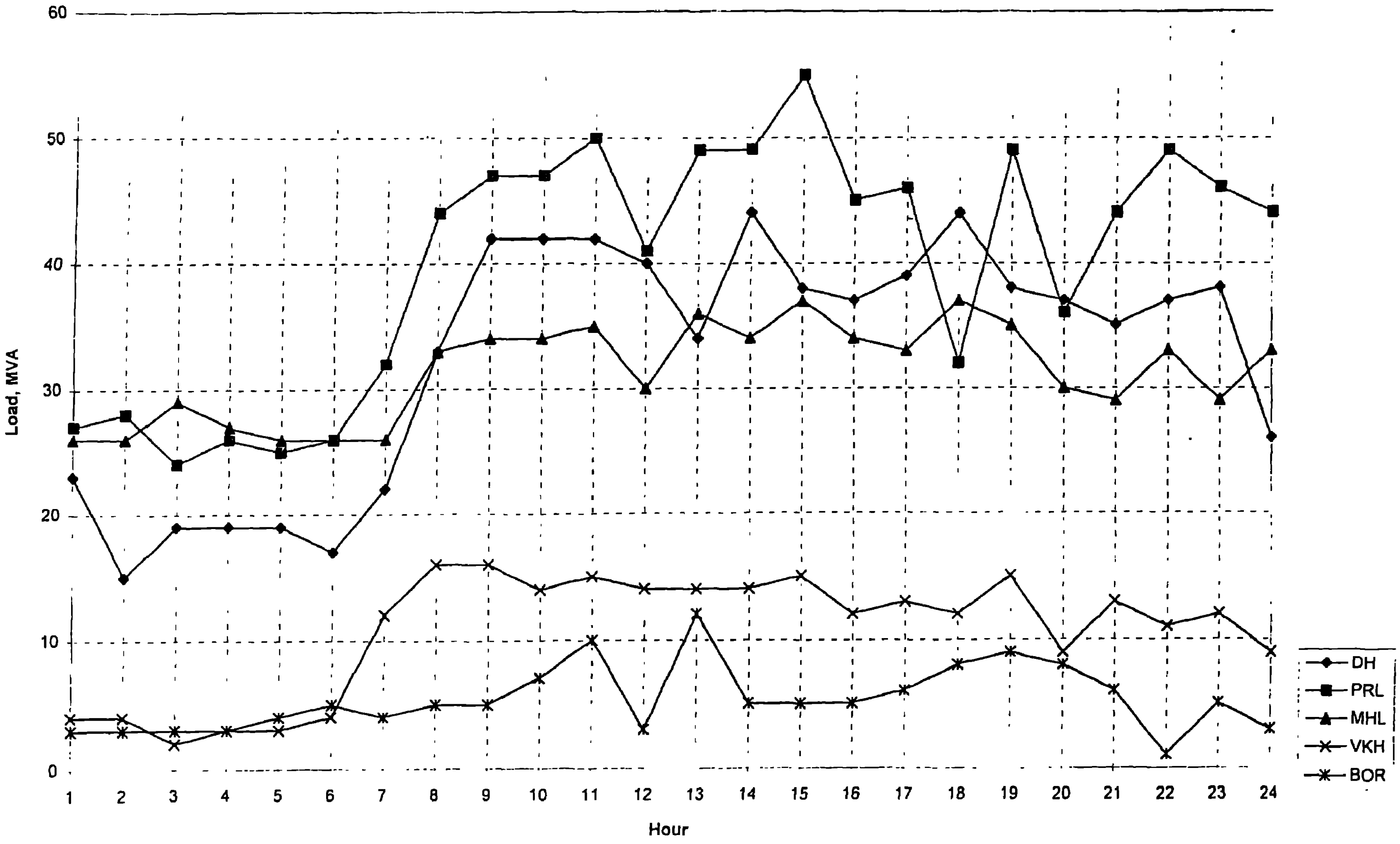


Graph 5

Tata Electric Companies, Mumbai

Load Curve of Direct Industrial Consumers for Some Selected Receiving Stations

Hourly Load Curve for 15/4/96 (Holiday)

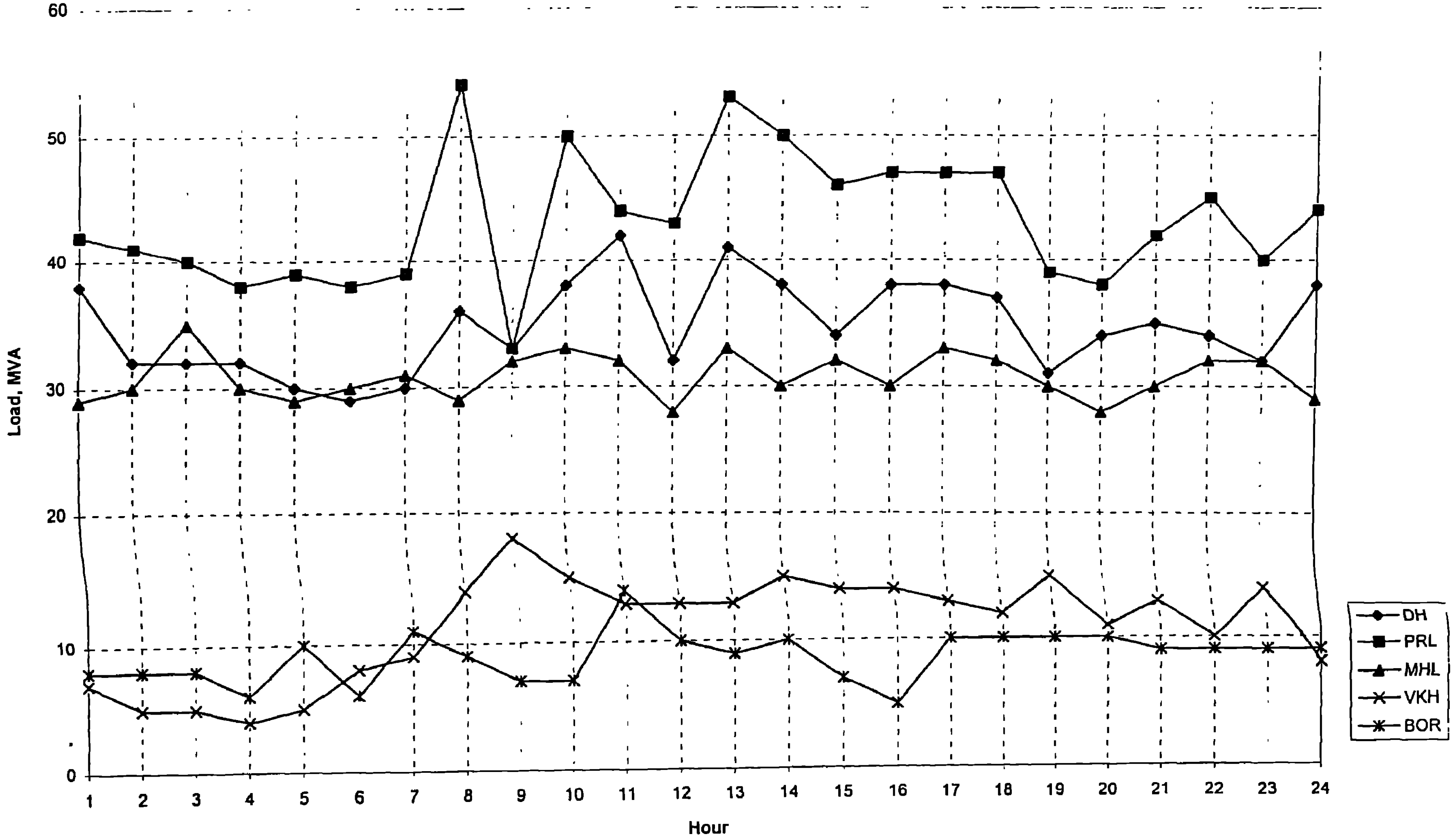


Graph 6

Tata Electric Companies, Mumbai

Load Curve of Direct Industrial for Some Selected Receiving Stations

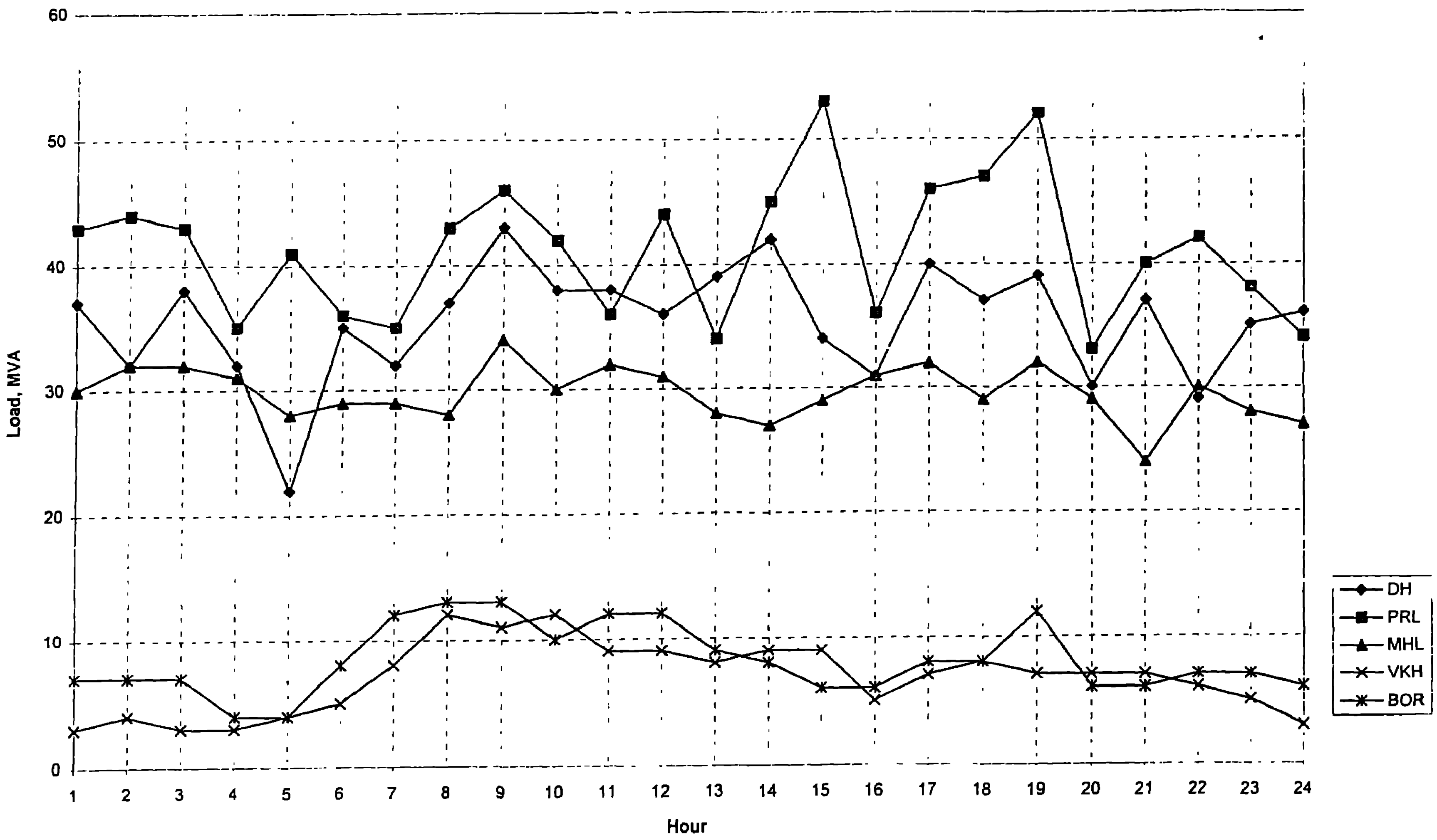
Hourly Load Curve for 24/5/96



Graph 7

Tata Electric Companies, Mumbai

Hourly Load Curve for 31/8/96

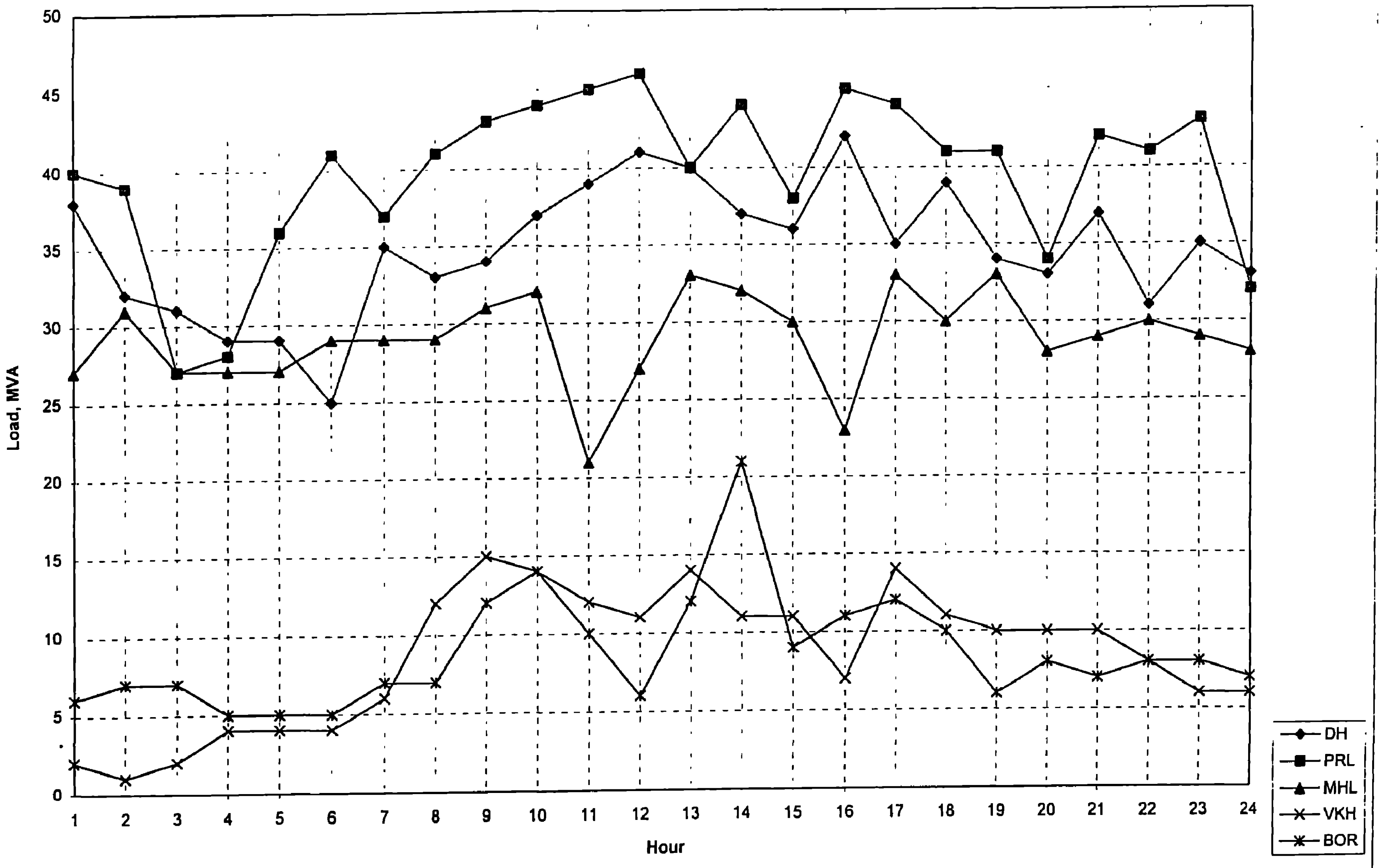


Graph 8

Tata Electric Companies, Mumbai

Load Curve of Direct Industrial Consumers for Some Selected Receiving Stations

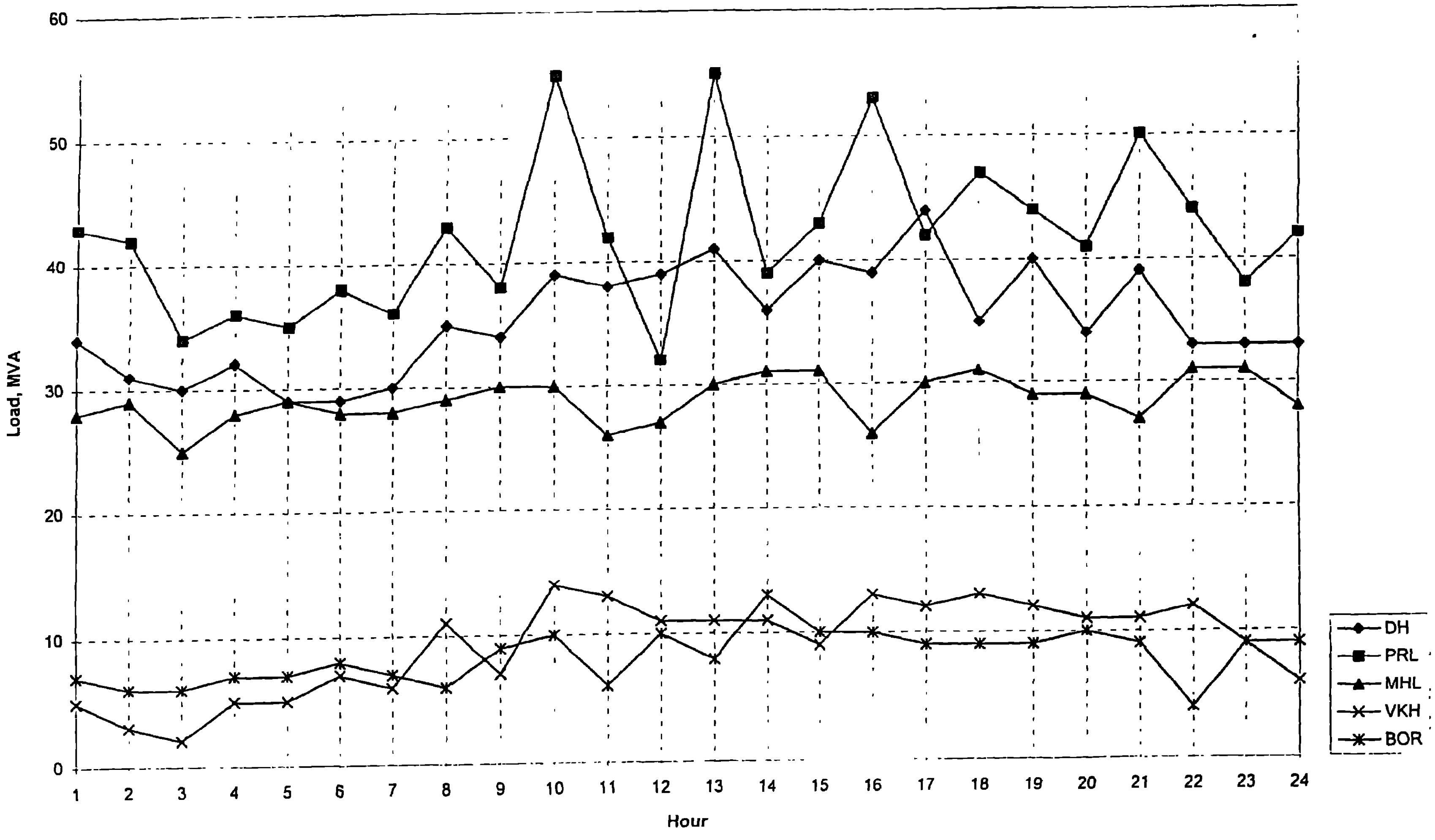
Hourly Load Cutve for 30/9/96



Graph 9

Tata Electric Companies, Mumbai

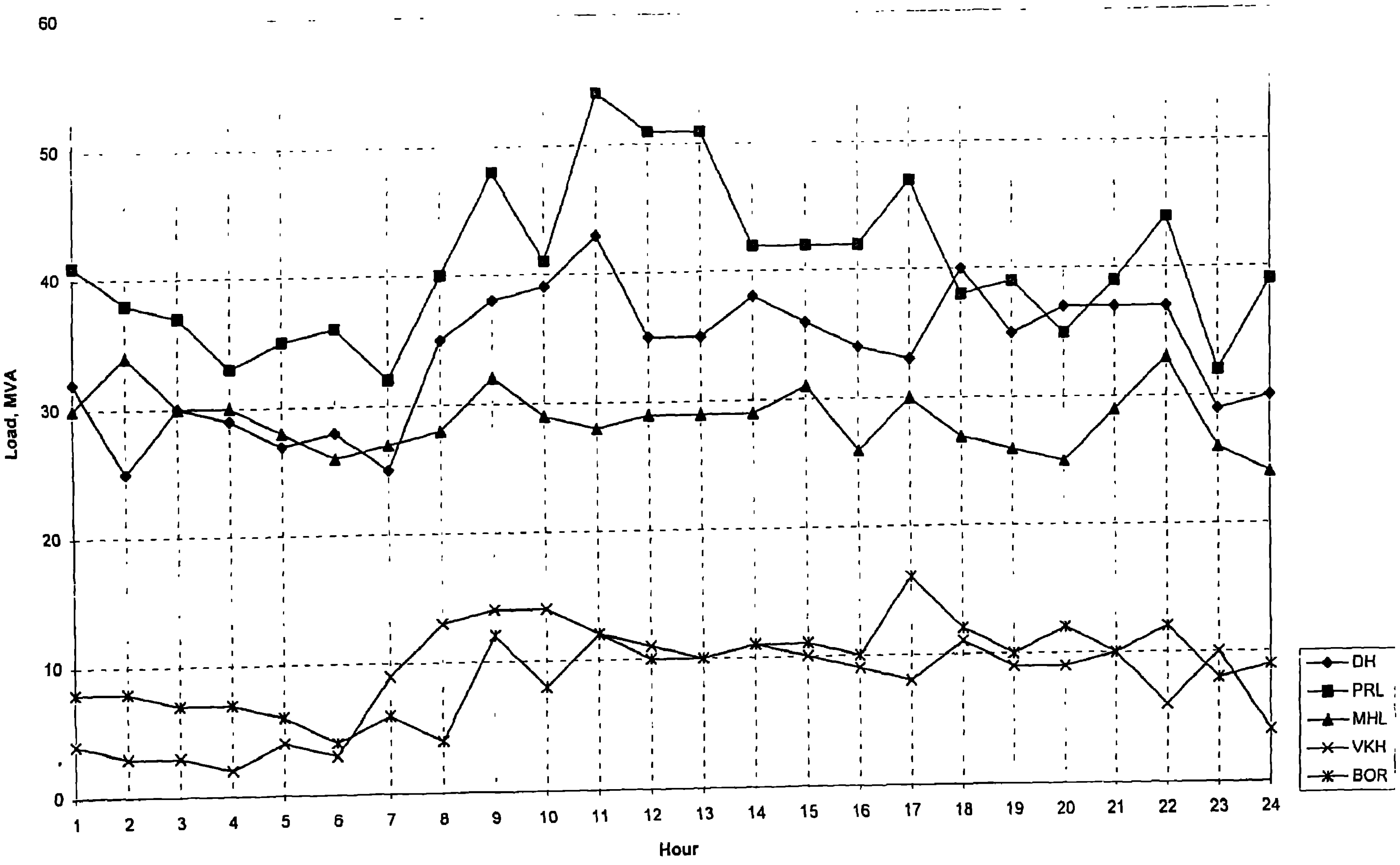
Hourly Load Curve for 17/10/96



Graph 10

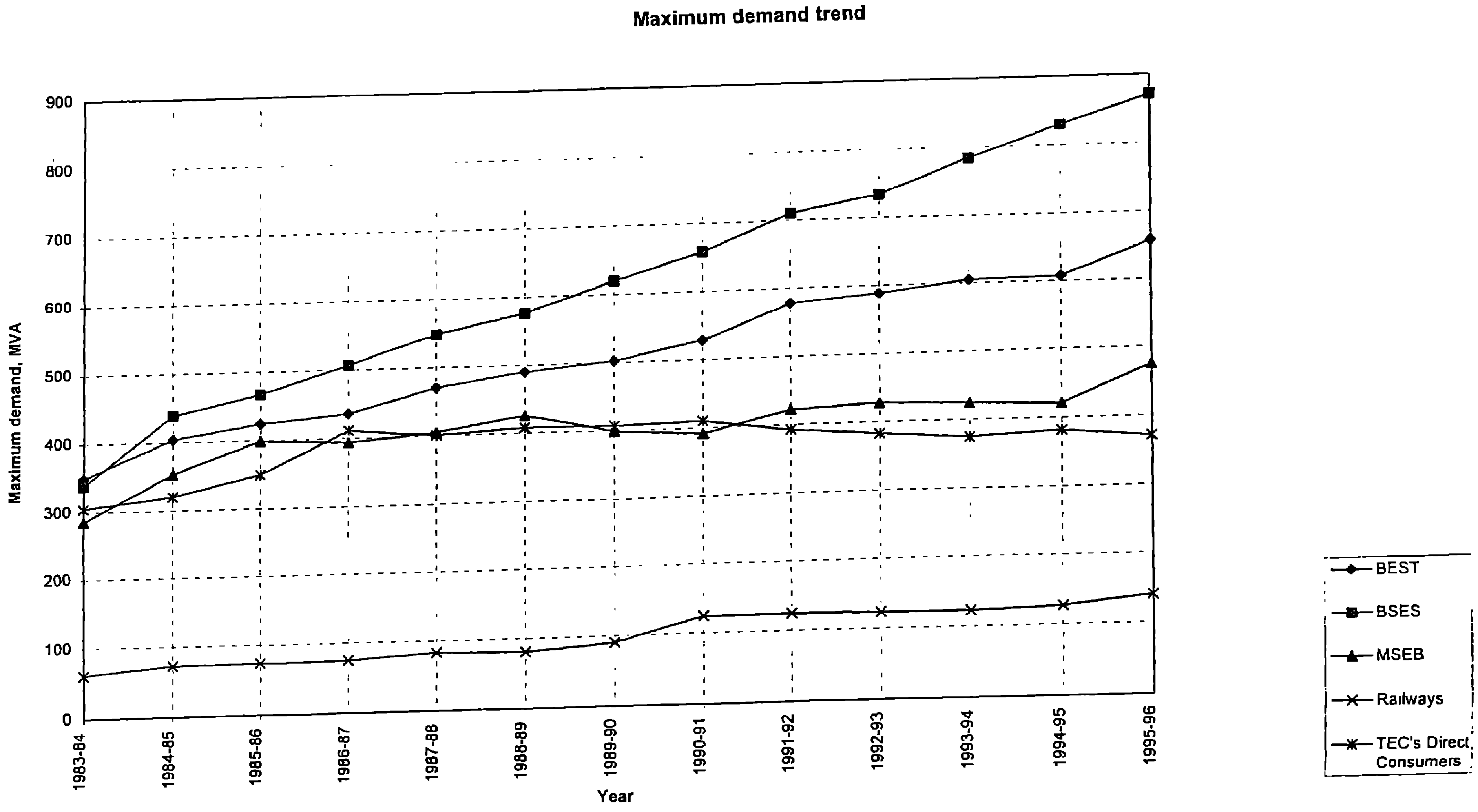
Tata Electric Companies, Mumbai

Hourly Load Curve for 31/12/96

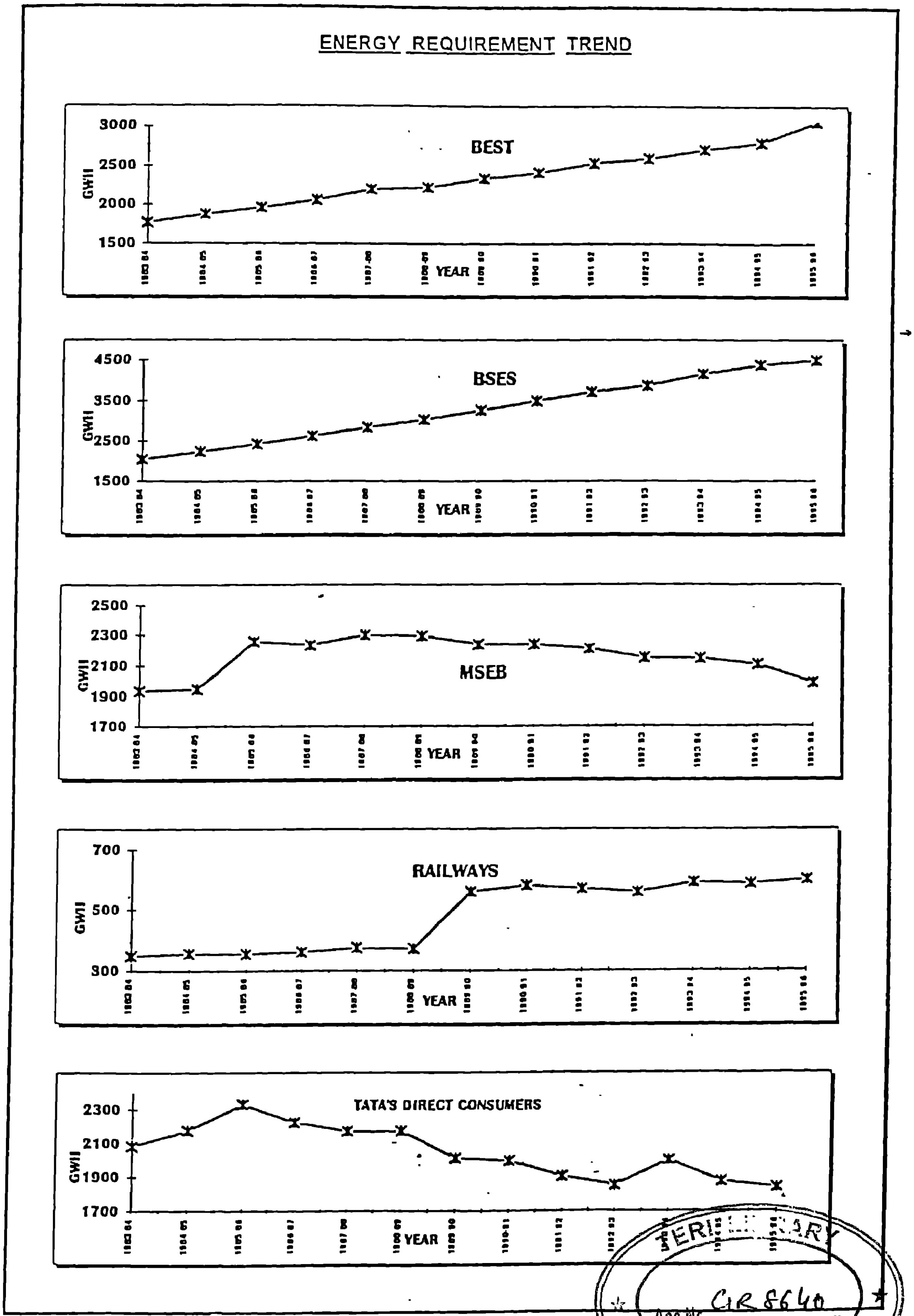


Graph 11

Tata Electric Companies, Mumbai


Maximum demand trend
Maximum demand, MVA
900
800
700
600
500
400
300
200
100
0
1983-84
1984-85
1985-86
1986-87
1987-88
1988-89
1989-90
1990-91
1991-92
1992-93
1993-94
1994-95
1995-96
Year
BEST
BSES
MSEB
Railways
TEC's Direct Consumers

Graph 12



Graph 13

Tata Electric Companies, Mumbai

TERI LIBRARY
ACC NO. GR 8640
NEW DELHI-110003